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DROUGHT LESSONS FROM AGRICULTURE

by

Herbert H. Fullerton

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DROUGHT LESSONS FROM AGRICULTURE^{*}

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Herbert H. Fullerton^{**}

1.0 Introduction

The typical freshman in my classes and probably most of the American public will agree with the assertions that drought and water scarcity are "bad" and conservation and efficient water use are in some sense "good". This sentiment is reflected by a wide array of public water projects, research, and educational programs which have as their justification more "goods" and/or fewer "bads". The severe droughts of the 1930s and 1970s in the U.S. provide examples of how complex water-based systems, such as agricultural production, respond to stress. It has been suggested that these examples possibly provide some indication of improved means for accomplishing more efficient resource utilization under "normal" conditions and for reducing the social and economic disruption associated with equivalent scarcity-based stresses in the future. The abiding question seems to be whether or not selected adjustments to resource scarcity utilized under the expediency imposed by a drought might be utilized as normal operating procedure. The symmetric variant of this question is: Are there selected adjustments utilized under the expediency imposed by a drought which should not be utilized or continued as "normal" operating procedure outside the extreme situation. As in most complicated choices, the most difficult and potentially rewarding exploration is discovering and establishing the reliability of conditions which would cause a particular drought expedient to be a safe and reliable long-run resource management.

Major sections which follow include:

1. Individual producers response to changes in resource availability.
2. Rationale for public involvement.
3. Range of choice in alleviating water scarcity.
4. Problems and opportunities stemming from agriculture's drought experience and their implications for the next drought and efficient resource utilization.

2.0 Producers' Perspectives and Management Choices

Resource scarcity is an ordinary fact of life for the manager of any production process. The problem with "drought" is that it may

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present the producer with a supply condition which was heretofore outside the range of his expectations. As such, it will require adjustments in the use of other inputs and likely in the amount and combinations of products to be produced which are also beyond the normal range of his experience. If additional water can be purchased at prices below the marginal value it will create in output, this will be done up to the point that its marginal cost (price) is exactly equal to the expected marginal return in value of product. If it is not possible to purchase water directly from another producer, then an alternate choice may be to develop additional supplies of water with soil and crop management, structures, reuse, ditchlining, sprinkling, etc. Again, this can occur profitably only up to the point where the cost of these capital improvements does not exceed the value of product which the water generated by it will produce. Both of these adjustments represent supply augmentation alternatives which are commonly used under irrigation and, to a lesser extent, in rainfed producing areas. The first requires full definition of water ownership such that it may be bought and sold within a given market (service) area and, thus, permit it to move from relatively low-value uses to higher ones. The second represents a purchase from the public domain and/or from other uncompensated downstream users who depend on upstream losses to supply their entitlement. In either of the above situations, the response is one of supply augmentation, viewing water as the only input. In most instances, it is possible to exercise a degree of substitution between water, which is relatively more scarce, and other inputs. This will occur up to the point where the marginal return in product relative to prices for all such inputs are equal, making it impossible to reduce cost or increase output by substituting one for another.

Changes may also be initiated on the demand side. This can be accomplished by changing the selection and amounts of products grown. Low-value/heavy water-using products, such as irrigated pastures, will be reduced in favor of those of higher value.

Any of the above responses in the private sector could be facilitated or impeded by the public sector. Possibly the most critical input to the choice process is knowledge of the extent and severity of water scarcity. In particular, early warning of impending drought condition, if correct, will permit the private sector to do the most possible to accomplish essential adjustments. Alternative roles and rationale for public intervention are briefly discussed in the section which follows.

3.0 Public Intervention

Basic choices open to the producer in times of drought are to employ supply-augmenting practices, purchase supplies from other producers in irrigated areas, and reduce demand via selection of crops which require lesser amounts of water per dollar value of output. From an individual's perspective, any and even all of these adjustments may leave him with very heavy economic losses or, at a minimum, net returns which are much below the "normal" expectation. So long as these individual producers are scattered throughout the country and no pervasive drought pattern evolves which threatens to have serious influence on national food supplies, the individual problem usually remains just that; i.e., there is no impetus for public intervention, either to provide incentive to adjustment or to compensate for unusual income

losses. The public sector will enter with drought mitigation and relief efforts under two basic formats. The first is when drought assistance is within the range of agency responsibility, such as the disaster loan provisions within FmHA. The second is emergency or ad hoc programs and supplemental appropriations borne of national and state concerns for the adverse wealth distributional consequences, existing or potential with continuation of drought and related economic losses in other sectors and communities. It is not always clear at what point "emergency" conditions are established sufficiently well to warrant full-scale public intervention, and this uncertainty can have serious and costly consequences for individuals who misjudge it and ultimately purchase fixed assets whose values are heavily influenced by the expected response of government in providing mitigation and relief.* Thus, it appears that government typically provides information, but this role is often expanded either formally with special legislation and appropriation or through existing programs. This is predicated on efficiency grounds only if the marginal value to society of reducing uncertainty and resultant value of production in the long run is greater than the cost of mitigation and relief efforts over the same period. Egalitarian motives and desires to redress obvious income changes appear to provide the basic motivation for public intervention in most instances.

4.0 Drought Lessons

It would be presumptuous to even attempt to list the full set of responses and attendant lessons associated with the two major U.S. droughts of this century. However, it may be instructive to explore a brief selection of reactions to drought and their possible implications for future water resource programs and management.

Following is a brief listing of observations and assertions based primarily on my experiences in dealing with farmers and agricultural interests in the intermountain region and with state, regional, and federal officials whose responsibility was to plan, provide, and administer drought mitigation and relief programs throughout the country. The list includes the following:

1. The prediction of timing and location of drought within a timeframe useful for management and planning were (are) virtually nonexistent.
2. Estimation of potential damages to agricultural industry, related sectors, and communities were grossly overstated in most cases.
3. The extent to which states and localities were able to respond to drought conditions appeared to depend greatly upon what facilities were already in place and the availability and cost of alternative water sources. In virtually all cases, alternative sources were less energy efficient than traditional supplies.
4. Agricultural sector prospectives were quite different than those of individual producers and consumers because of the unusually low price and income elasticities associated with agricultural commodities.

*This problem is most common in utilization of flood plains, but many similarities can be found in settlement and farming in drought-prone areas.

5. Flexibility in resource use in times of drought appears to be directly related to the definition of property rights in water and security of tenure in ownership of such rights.
6. Expectations concerning the role of government formulated from past involvement may render lower cost private alternatives to drought mitigation infeasible. Expansion of the role of government to facilitate efficiency in resource allocation and use seems questionable but is more easily justified on egalitarian grounds.
7. Practices initiated for the purpose of mitigating drought may have serious long-run consequences when similar droughts occur in the future, including water banking, which must include individual private sector incentives to be effective in accomplishing intertemporal, interspatial, and intersectoral flexibility in resource use.
8. The simple concept of use efficiency becomes extremely complicated when superimposed on drought conditions and the related concepts of water conservation and economic efficiency.
9. Drought research and information requirements cannot be usefully separated or financed apart from basic programs in meteorology, water management, land/water interrelationships, etc.

4.1 Drought Prediction

Drought prediction is only beginning to lend itself to scientific advance and appears still to be very much in the descriptive stages of development. At this point in time, we have no uniformly applicable definition of drought, except that the availability of water, current and expected, is less than a locally defined normal condition. Some areas in the world are successfully exploited for agricultural purposes under conditions of perpetual drought. In the U.S., some of our most severe problems in the 1970s drought were in high rainfall areas where water is relatively abundant. Within limits of our current knowledge and technology, it appears that two major improvements in drought prediction are within our capability. The first is to develop drought probability surfaces specific to a narrow range of surface agricultural uses for major producing areas throughout the world. Most all precipitation, evaporation, and soil and surface storage information are available and could easily be translated relative to existing and potential demands which could be placed on the water supply. The primary value of this type of information is to prevent inadvertent location of activities which would be unprofitable with higher drought sensitivities than could be maintained in a given area.

The second concerns the assembly of microweather, precipitation, and water storage conditions in a much broader scale than currently exists. It appears that droughts are present in a world regional scale on a much more regular basis than in any given smaller agricultural area. Drought prediction in this broader context could facilitate a more reasonable management strategy for feed grain stocks and planting, storage, and export. Decisions in primary producing areas outside the drought zone could be modified to offset shortfalls in production in other regions of the world. Only in the highly developed agricultural countries is any concentrated effort being made to gear microplanting decisions to expected yields and production in other producing regions.

The feasibility of this type of global prediction would be predicated on the ability of major unaffected producing regions to expand and contract production in ways which increased their net profits above levels which would have been generated without knowledge of storage, production, and water supply conditions in the rest of the world.

4.2 Damage Estimation

Short-run damage estimation is an area which has been seriously abused in our recent experience with drought. Responsible individuals from USDA, who were assembling expected losses from drought at an early point in the growing season, indicated that the sum of individual states' claims made World War II look like a sandbox scuffle. Most often, state and federal assistance to victims of disaster are assembled after the event, i.e., the dam has burst, the flood has subsided. However, in the case of drought, major assistance and mitigation funding was available based on expected levels of damage. Hence, considerable incentive was provided for reporting the worst possible contingencies in lieu of solid ex post information on real damages.

It is interesting to note that although reliable agricultural production and transportation models have been rather uniformly available throughout North America since the early 1950s, in the fall of 1977, it was not possible to generate a single 'what if' solution to evaluate the impact of continued drought for major producing regions of the U.S. with fewer than six months response time. This was at a time when state agricultural officials had been scrambling from 6 to 24 months and the federal drought task forces for more than six months. Very reliable state, national, and world regional optimizing models are available for use in giving ex ante and ex post assessment (measurement) of drought impacts. A major significant lesson from our drought experience in the 1970s was that models developed primarily to evaluate economic efficiency of production could find valuable and timely application in drought assessment. Problems remaining are coordination of data management, finance, and access of these at state and local levels. The best current information is not well suited for dissemination to governors and other state and local agricultural leadership.

4.3 Alternative Water Sources

Many reactions to the 1930s and 1970s drought cannot be repeated in the event of a future drought. For example, in instances where wells were drilled and pumped as a supplement to insufficient rainfall (as in the Texas High-Plains area in the 1930s) or to supplement surface irrigation water supplies (as in Central California), if these secondary sources continue to be used as primary supply, then they will not be available to offset extreme scarcity. However, if cropping patterns and land area in production do not change following the drought, it will require more severe conditions in these areas than occurred in the 1930s and 1970s to introduce the same potential for losses.

Comparisons of the response to drought in the midwest and intermountain west/far west revealed some interesting possibilities. Technology and structures, although heavily used to mitigate water scarcity in California, Utah, and Idaho, appear to offer much greater long-run benefits in the marginal rainfall areas of the Great Plains and midwest. The extent to which technology can be applied to expand sustained water yields is only beginning in the higher rainfall areas but is rather

thoroughly exploited in the more arid western states.

Institutions which facilitate effective utilization of scarce supplies are also more highly developed in the arid producing regions; and, as is the case with technology, management, and structures, the greater opportunity for improvement is in the higher rainfall areas.

4.4 Drought Perspectives

The discomfort associated with drought varies greatly depending on whose ox is or is not receiving water. For the individual producer who is unfortunate enough to find himself in the midst of a drought, he has few alternatives but to minimize his losses and seek the sympathy of a larger public to provide funding for mitigation and relief programs. When drought, however severe, is scattered rather widely making it difficult to attract state and national concern, losses will fall heavily and without mitigation upon the producer. The perspective of the industry and consumers of agricultural products is quite different from the individual producer. The perspective of the consumer may coincide with the individual producer under conditions where mitigation efforts can be successful in holding agricultural production at high levels and food prices at relatively low levels. The industry perspective, because of low price and income elasticities, would favor reduced levels of total production associated with drought because they would result in greater than proportional expansions in total income generated by that production. Thus, what the agricultural industry may gain by expanded revenues resulting from reduced production will come at the direct expense of consumers. The design and eventual public support of drought mitigation programs will undoubtedly be influenced by the relative political weights of groups representing these three perspectives.

4.5 Flexibility of Water Use

The ease with which scarce water supplies may be moved--interuse, intersectorally, intertemporally--appears to be directly related to the problem of private property rights and security of tenure in private claims on flow resources. Contrary to conventional wisdom, granting of perpetual rights of ownership to a flow resource can have a very positive influence on the availability of that resource for other uses in time of unusual short supply or when other uses can generate values in use which exceed those of current use of the resource. Numerous examples abound concerning interseasonal trades (water banking) among farmers whose sources of supply are differently affected by drought as is the case between primary flow and storage sources. In Utah, interuse and interseasonal markets have evolved which have resulted in significant improvements in the total net value of a very scarce water resource.*

Conventional wisdom supports treating individual use of flow resources as a temporary privilege which may be revoked by higher authority in times of scarcity or when higher value uses appear. Use entitlement may be subject to periodic reviews to see if it is being used properly with the result that the planning horizon of the individual water resource manager is fixed not by the productive life of other capital which must be expended to utilize the water effectively, but by

*B. Delworth Gardner and Herbert H. Fullerton, "Transfer Restrictions and Misallocation of Irrigation Water," American Journal of Agricultural Economics 50(3):556-571 (August, 1968).

legal legislative or bureaucratic process. If no property right is established in the resource and uncertainty is increased by periodic review, the larger burden of providing complimentary investment funds for water development and management must fall on the public budget.

4.6 Public Intervention and Producer Expectations

The recent drought in North America demonstrated the rather high level of mobilization, especially of mitigation and relief funding, which can be generated, given a sufficiently sympathetic Congress and executive. However, such mobilization can have a very significant influence on the location of economic activity, production, and management decisions of the private sector. A discontinuance of this historical level of governmental response to similar conditions of water scarcity in the future will result in very large economic losses to the private sector. The reasons for this are simply that some lands will be farmed more intensively than would be the case if farmers did not hold the expectation that the larger public would offset their losses in the event of drought. A long-run precedent for federal relief efforts being incorporated into individual locations and management decisions is provided in flood plain management and relief programs provided in the wake of flooding and drought.

Perhaps a more serious problem related to the potentially incorrect assessment by the private sector of the future response of government is that private alternatives to public mitigation and relief efforts are rendered infeasible. If the agricultural sector knew, with high probability, that all losses associated with drought would be carried by that sector, it would become feasible to sell drought insurance in those areas where history of drought and attendant losses made insurance a feasible alternative. Additionally, it seems reasonable to expect that many drought-prone producing regions would not be committed to intensive agriculture but would remain in crops whose value would be only minimally affected by variability in water supply.

An interesting possibility exists for redistributing industry-level income gains, resulting from reductions in total production, to individuals who suffered significant income losses. The feasibility to introducing a tax scheme or area-specific prices which would accomplish this redistribution are quite beyond current capability but should be investigated along with more conventional technologic, structural, and bureaucratic approaches.

4.7 Short-Run Versus Long-Run Incentives

As mentioned under sections 4.5 and 4.6, effective short-run drought mitigation and relief efforts, whether introduced by the private or public sector, may result in less than desirable long-run water management practices. Perhaps the most obvious cases are provided by the introduction of groundwater mining to offset reduced rainfall, surface runoff, and storage. If pumping continues after the drought to the limit of economic feasibility, then capacity to withstand future droughts will be reduced and rendered more expensive. Even under circumstances where new wells are utilized only to the extent of sustained yield, some provision must exist for maintaining storage in the system to offset future drought contingency. The extent to which short-run drought measures may be effective as long-run conservation measures is restricted greatly by the return flow and reuse of water which are very common in irrigated agricultural systems.

4.8 Efficiency in Water Use

The misleading simple concept of water use efficiency becomes even more complicated when reactions to drought conditions are being examined for potentially valuable lessons in conservation of water. Many practices, including sprinkling, ditchlining, and field catchments are merely borrowing from our neighbors downstream or from ourselves and our neighbors in future years. It appears that the only real water savings are those associated with practices and technologies which reduce evaporation losses from the total system, thus increasing the proportion of total water supply at any given point in the system which has a positive time and place value. This is not to say that certain technologies and management practices introduced in reaction to drought are not totally feasible, both physically and in a long-run economic sense. However, determination of their long-run feasibility requires careful measurement of the opportunity value of water which is captured from downstream and future uses whether currently identified or not.

5.0 Drought, Water Management, and Conservation: Some Conclusions

Based on our limited experience with drought as a somewhat isolated resource scarcity problem, it appears that very little can be gained by continuing to treat it in isolation from other problems and information requirements related to resource scarcity. This observation becomes especially clear when finance is being sought to study drought as a local or national phenomena. Drought, beyond the relief efforts which typically reside outside the resource management agencies, is nothing more or less than a condition of unusual (unexpected) water scarcity which prompts more than individual concern. Drought provides invaluable lessons, especially in the evolution of institutional forms, because the stresses associated with it cause us to reexamine our conventional wisdom and, in some cases, establish and reestablish research attention at levels of analysis which can make it possible to give fuller utilization of conventional data and research information for immediate management and policy.

The extent to which these modifications in institutions, management, and policy can have impact on water conservation will depend upon their long-run economic feasibility and recognition of the fact that in complex water systems, one man's conservation is another man's drought.